Documento de Trabajo

8 7 2 0

"A CLASSIFICATION OF THE MULTIPLE CRITERIA DECISION MAKING MODELS"

Luis Angel Guerras Martín

VI SIMPOSIO

PLYMOUTH POLYTECHNIC

FACULTAD DE CIENCIAS ECONOMICAS Y EMPRESARIALES - UNIVERSIDAD COMPLUTENSE

FACULTAD DE CIENCIAS ECONOMICAS Y EMPRESARIALES - UNIVERSIDAD COMPLUTENSE
Campus de Somosaguas. 28023 - MADRID

Nº C → X-53-229590-X

Nº E → 530740265X

VI S I M P O S I O

PLYMOUTH POLITECHNIC - FACULTAD CC. ECONOMICAS
(UNIVERSIDAD COMPLUTENSE)

PONENCIA:

"A CLASSIFICATION OF THE MULTIPLE CRITERIA DECISION MAKING MODELS"

LUIS ANGEL GUERRAS MARTIN
DEPARTAMENTO DE ORGANIZACION DE EMPRESAS

MADRID, JUNIO DE 1987

A CLASSIFICATION OF THE MULTIPLE CRITERIA DECISION MAKING MODELS

1.- DECISION MAKING IN BUSINESS ORGANIZATIONS USING MULTIOBJECTIVE MODELS

Decision making is one of the most important functions of the managers in a business organization. As Simon (1977) suggests, some of the decisions can be considered structured and some others unstructured. The former are those that are made a lot of times in a similar way and also those that can be analysed with a formal model for its resolution. Determination of production level for a period of time is one example of this kind of decisions.

Unstructured decisions are related with relatively complex and new situations when it is not possible to have rules or specific methods for making the decision. Merging with other corporation or developing a new activitie are examples of unstructured decisions.

The interest of this distinction is because of the techniques that is necessary to use in every situation. In this sense we'll focus our attention in structured decisions in which we can use formal and complex models, usually with a mathematical character, that are able to represent the problem we have to solve.

Moderns techniques for structured and complex decisions are included in the commun denomination of Operations Research or Management Science. Although the set of techniques under this denomination is not homogeneous, we can mention some of them such as the Theory of Games, Mathematical Programming, Markov Chains, PERT and CPM methods, etc. One of the newest areas and with a great development is the so named "Multiple Criteria Decision Making". This area includes a lot of mathematical techniques for managing decision situations in which several objectives or criteria are simultaneously considered.

This kind of techniques try to overcome the limitation of traditional techniques in the sense that all the consecuences of every alternative can't be expressed in terms of an unique evaluation function. In the real world, every decision maker uses a lot of criteria to evaluate differents alternatives. Multicriteria techniques allow to manage this aspect through mathematical models.

Until some years ago there were not appropiate instruments to manage decision making situations with multiple criteria. In the sixties, mainly thankful to Charnes and Cooper developments, it begins to appear some research issues about multiobjective decision models. However, it is necessary to wait until the seventies to look how this area has a great development. As a consequence, nowadays, we have several techniques for making decisions with multiple objectives -specially in the mathematical programming field- with new possibilities of application in business organization decisions.

2.- A CLASSIFICATION OF MULTIOBJECTIVE TECHNIQUES BASED ON ANALYST-DECISION MAKER RELATIONSHIP

In spite of the short time of development of Multiple Criteria Decision Making, an elevate number of different techniques have been proposed until now. Then, it is necessary to analyse the main characteristics of the techniques, in order to establish a classification. This classification can facilitate the utilization of a specific technique.

Some different criteria have been proposed and every one of them is refered to a different aspect. Rietveld (1980, chap. 10) suggests a set of criteria for multiobjective techniques classification. Some of these criteria are also used by other authors. The classification criteria suggested by Rietveld are based on the number of available alternatives, the scale of measurement of the data scale, the availability of information about priorities or preferences, the way in which preferences are incorporated to the model, the number of alternatives to present to the decision maker at the end of the process decision, the uncertainty about data used in the model and the number of decision makers.

Zionts (1980) suggests a criterion of classification based on the mechanisms for generating alternatives. Hwang and Masud (1979) use in their own classification a criterion related with the kind of information the decision maker supplies about his preferences. Finally, Cohon (1978, chap. 5) suggests a mixed classificatory criterion in which includes as an essential part the relationship between analyst and decision maker in the decision process.

An schematic resume of the criteria suggested for a classification of multiobjective models is presented in Table 1. As it can be observed, the different criteria generally are not incompatible among them. Then, the appropiate combination of them can generate a lot of different classifications.

Although all the criteria suggested in Table 1 are important we want to establish our classification in the last of them, that is, in the relationship between the analyst and the decision maker as essential subjects in the decision process. The reason for this selection is the importance of that relationship from the point of view of the organizations and, specially, in business decision making processes. As a consequence, the different possibilities of relationship have different directions in information flows between decision maker and analyst. The role of both subjects in the organization is also modified.

Before establishing the classification, it seems necessary to define the key concepts we are managing from the beginning: decision maker and analyst. Chankong and Haimes (1983, pg.8) propose a good definition for decision maker: "an individual or a group of individuals who directly or indirectly furnishes the final value judgment that may be used to rank available alternatives, so that the 'best' choice can be identified".

From the above definition it is possible to point the absolute important role of the decision maker: the alternative that will be selected at the end of the process will depend on the information supplied by the decision maker. This information is essentially subjective and comes from the preference structure of the decision maker.

The analyst represents the specialist in decision techniques. He is the technician that analyses the problem and helps the decision maker to identify an alternative. The information the analyst manages is essentially objective,

C R I T E R I A	K I N D S O F T E C H N I Q U E S
1) NUMBER OF AVAILABLE ALTERNATIVES	- Finite - Infinite
2) SCALE OF MEASUREMENT OF THE DATA	- Cardinal - Ordinal - Mixed
3) INFORMATION ABOUT PREFERENCES	- Information exists - Information doesn't exists
4) WAY OF MODELING PREFERENCES	- Utility Functions - Goals - Minimum standards - Lexicographic
5) NUMBER OF ALTERNATIVES IN FINAL SELECTION	- One alternative - Several alternatives
6) UNCERTAINTY ABOUT DATA	- Uncertainty - Certainty
7) NUMBER OF DECISION MAKERS	- One decision maker - Multiple decision makers
8) MECHANISMS FOR GENERATING SOLUTIONS	- Explicit solutions - Implicit solutions
9) KIND OF INFORMATION ABOUT PREFERENCES	- Ordinal - Cardinal - Mixed
10) RELATIONSHIP BETWEEEN ANALYST AND DEC. MAKER	- Information flow analyst-->d. maker - Information flow d. maker-->analyst - Information flow d.maker<-->analyst

TABLE 1

CRITERIA FOR A CLASSIFICATION OF MULTIOBJECTIVE TECHNIQUES

that is, just the opposite that in the other case. He generates information about the problem and offers it to the decision maker. Furthermore, he tries to translate information about preferences into the formal necessary mechanisms in the model.

The roles developed by the decision maker and the analyst are both essential and complementary. However, it is necessary to delimitate the functions we have defined. The responsability of the decision is in the decision maker and not in the analyst.

Once we have defined the bases and concepts of the classification, we can analyse the different kinds of relationship that can be established between analyst and decision maker, in terms of information flows, and observe the main characteristics of these relations.

a) Information flow "analyst---->decision maker": One of the possibilities we can observe supposes that the information flow comes from the analyst to the decision maker. In this kind of techniques, the analyst objectively studies the problem and gets from it the set of efficient alternatives or a significant subset. This information is shown to the decision maker who chooses the alternative that is more appropiate for his preferences. Then, it is not necessary for the decision maker to explicit his preference structure. Figure 1 shows graphically this relationship.

The techniques in this kind of relationship are named "generating" techniques because his main target is to generate the set of efficient alternatives. Among this group we can mention the "weighting method" or the "constraint method".

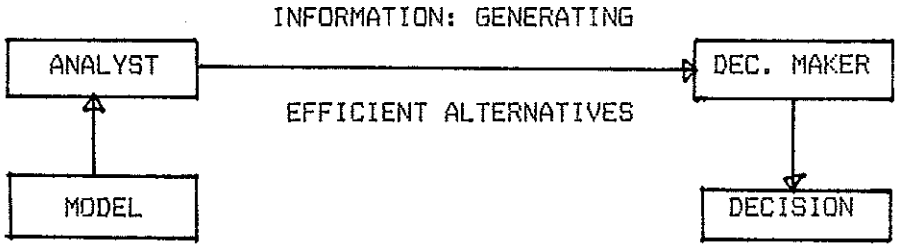

FIGURE 1. GENERATING TECHNIQUES

b) Information flow "decision maker----->analyst": In this second kind, the main information flow of the decision process has the opposite direction of the previous one. That is, the information flows from the analyst to the decision maker. In these techniques it is necessary to have explicit preferences from the decision maker about the different objectives of the problem. This subjective preferences are carried to the model by the analyst in an operative way.

Once the model has been built with the decision maker preferences included, its solution represents the alternative selected by the decision maker as his course of action. The final solution, therefore, comes directly from the model because the decision maker preferences are included like a part of it. Figure 2 shows the relation, in this case, between analyst and decision maker.

The techniques in this group are named "techniques with a priori information", in a reference at the moment the preferences are made explicit by the decision maker in the decision process. Among these techniques we can mention Goal Programming and the Generalized Inverse.

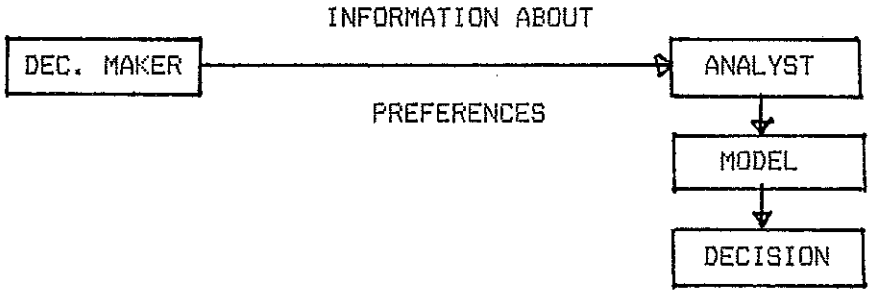

FIGURE 2. TECHNIQUES WITH A PRIORI INFORMATION

c) Information flow "analyst<----->decision maker": Finally, there are a lot of techniques in which the information flow has a double direction: from the analyst to the decision maker and vice versa. In this kind of techniques, the decision maker gives the analyst partial information about his preferences at the beginning of the process. This information is incorporated to the model by the analyst in order to generate an alternative. This alternative is

presented to the decision maker for evaluation and can be accepted or rejected. In the last case, the analyst requires more information to the decision maker about his preferences in order to look for another alternative more acceptable. This process is graphically shown in Figure 3.

The interchange of information is the main characteristic of this kind of techniques. The decision maker progressively gives information about his preferences. On the other hand, the analyst offers an alternative to the decision maker in every stage for its evaluation. This interchange of information process has an interactive character; therefore, this is the reason why these techniques are called "interactive". There are an important number of them already developed but we can mention, as examples, the Geoffrion, Dyer and Feinberg method, the STEM method or the Zionts-Wallenius method.

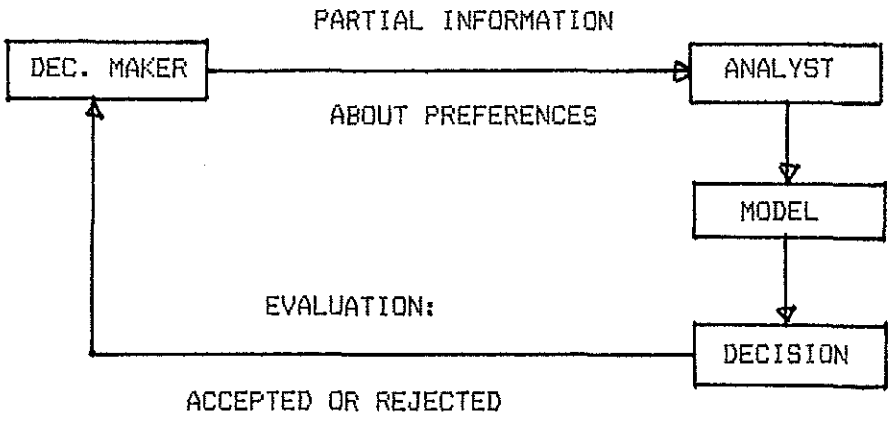

FIGURE 3. INTERACTIVE TECHNIQUES

A classification of multiobjective techniques based on the criterium developed is shown in Table 2. This classification just try to be orientative about the main techniques available in Multiple Criteria Decision Making area.

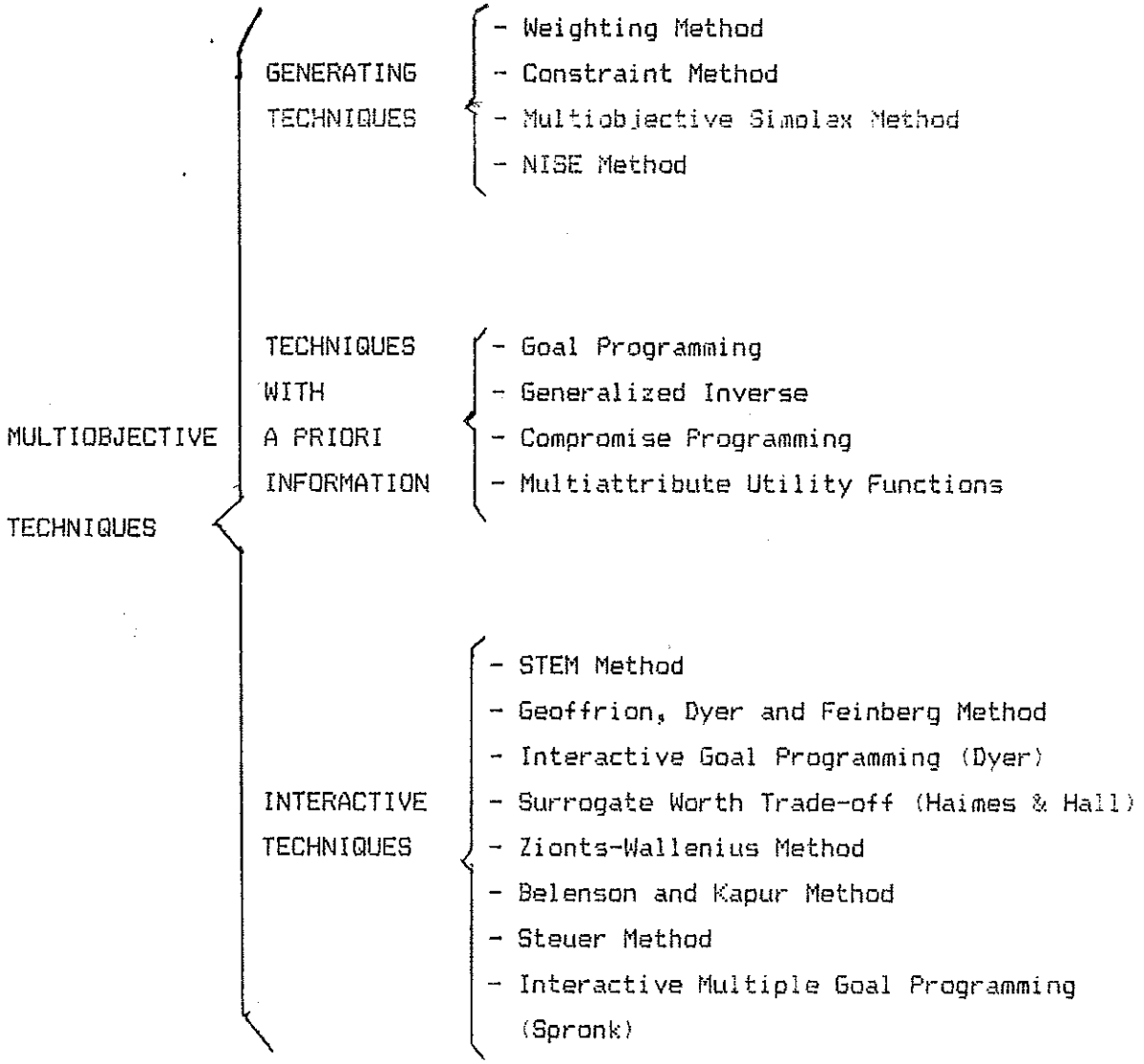

TABLE 2

MULTIOBJECTIVE TECHNIQUES CLASSIFICATION

4.- TECHNIQUES WITH A PRIORI INFORMATION

As a second important group of multiobjective techniques, we find those techniques in which the information flows from the decision maker to the analyst, just the opposite that in the previous group. In this kind of techniques, the analyst requires the decision maker to make explicit his preference structure about the different objectives. With this information included in the model the analyst solve and gets the best solution for the preferences expressed.

With these techniques, it is possible to order the alternatives basing the ranking in the level of preference by the decision maker. This order can be establish in an ordinal way, in a cardinal way or both. If it is possible to order the set of alternatives, it is not necessary to analyse the whole set of efficient solutions. Then, the volume of information managed in the solution process is considerably reduced.

In the techniques with a priori information it is necessary to make explicit decision maker's preferences. As we have seen, this is the main information used by the analyst to guide the decision process. Even in not very complex problems, the explicitation of preferences can be considered difficult by the decision maker at the beginning of the process without an appropiate information about the problem. Furthermore, the decision maker can modifie his preferences because the solution obtained is not considered sufficiently satisfactory. This problem suggests the introduction of some feed-back mechanisms in this kind of techniques but this is a part of interactive techniques.

Among the techniques that incorporate a priori information, it is possible to distinguish two different subgroups:

- Techniques based on minimization of some distance.
- Techniques based on definition of some utility function.

The first subgroup includes those techniques that try to minimize the distance between achieved objectives and a certain reference solution. If the reference solution can be considered "satisfactory" in the sense of

b) Local information about preferences: the articulation of preferances in a global way at the beginning of the process requires from the decision maker an important effort in global comprenhesion of the problem. Some decision makers can even consider themselves unable to make it. In general, it is easier to articulate preferences about a particular solution and this is the idea of interactive techniques.

c) Learning process: May be, this is one of the most interesting aspects of interactive techniques. Really, the decision maker learns about the problem while he is, in the iterative process, articulating preferences and getting information. As an important consequence of this learning process, the decision maker can modifie his preference structure during the decision process.

Spronk (1981) suggests that not only the decision maker but the analyst can learn in the process. Due to information obtained, it can become necessary to modifie the decision model previously defined and structured by the analyst.

d) Active participation of the decision maker: In interactive techniques, the participation of decision maker is much more intensive than in other techniques because he has to guide the process with his progressive articulation of preferences. This characteristic has pros and cons.

On one hand, the participation of the decision maker in the decision process makes him more engaged with the solution obtained. Then, the possibilities of implementing this solution increase. In this sense, it is important to point that the lack of trust in a technique by the decision maker makes it unuseful in practice.

On the other hand, interactive techniques require from the decision maker more time and attention. This can be a serious disadvantage because "the decision maker may not feel that the investment of the time required provides any better decision making than ad hoc approaches" (Goicoechea, Hansen and Duckstein, 1982, pg. 218). Some authors, as Ignizio (1982), are pesimist in this aspect and they think that this kind of techniques require a lot of time and effort for a busy decision maker who will not want to participate.

e) Analyst participation: Relative to analyst participation, it is necessary to say that this is accomplish at the beginning of the process (model formulation, etc.). During the process, he must help the decision maker in the comprehension of the problem, analyse the solutions obtained and, if it is necessary, revise the model (Spronk, 1981). In many cases, some of this typical analyst tasks are accomplished by a computer.

f) Other characteristics of interactive techniques: Finally, we can mentioned two characteristics that can be considered as disadvantages of interactive techniques, as Hwang and Masud (1979) do. One of them is related with the fact that the validity of solutions obtained depends of the accuracy of the decision maker in the expression of his preferences in every iteration. This disadvantage, however, is not exclusive from interactive techniques it is a commun problem among some multiobjective techniques and, specially, those that incorporate a priori information.

The second problem, more technical, is related with the lack of guarantee of convergence in some interactive techniques. This problem suggests the necessity of an appropiate selection and evaluation of the different methods and, even, to the development of new and more effective techniques.

6.- CONCLUSION

In this work we have tried to present a classification of multiobjective techniques based in the relationship between the main subjects of decision process: analyst and decision maker. These relations, in terms of information flows, have important consequences for decision making processes in business organizations. Then, the analyst develops assistant and technical specialization functions in the organization, but without direct responsability in decision making. His functions, therefore, are very similar to those of a line assistant. On the other hand, the decision maker is the person that assumes the responsability of decision making, and is a part of the authority structure in the organization of the firm.

In this sense, we think that active participation of the decision maker in the decision process makes him to accept better the alternative selected and the possibilities of implementation grow. Then, the interaction between decision maker and analyst is necessary. New techniques developed try to assume this interactive process and some "traditional" techniques are adapted in the same direction. Then, the set of interactive techniques can be considered the essence of Multiple Criteria Decision Making.

BIBLIOGRAPHY

- COHON, J.L. (1978).- "Multiobjective Programming and Planning", New York, Academic Press.

- CHANKONG, V. and HAIMES, Y.Y. (1983).- "Multiobjective Decision Making. Theory and Methodology", New York, North-Holland.

- GOICOECHEA, A.; HANSEN, D.R. and DUCKSTEIN, L. (1982).- "Multiobjective Decision Analysis with Engineering and Business Applications", New York, John Wiley and Sons.

- HWANG, C.L. and MASUD, A.S.M. (1979).- "Multiple Objective Decision Making-Methods and Applications: A State-of-the-Art Survey", New York, Springer-Verlag.

- IGNIZIO, J.P. (1982).- "Linear Programming in Single and Multiple Objective Systems", Englewood Cliffs, Prentice-Hall.

- RIETVELD, P. (1980).- "Multiple Objective Decision Methods and Regional Planning", Amsterdam, North-Holland.

- SIMON, H.A. (1977).- "The New Science of Management Decision", Englewood Cliffs, Prentice-Hall.

- SPRONK, J. (1981).- "Interactive Multiple Goal Programming Applications to Financial Planning", Boston, Martinus Nijhoff.

- ZIONTS, S. (1980).- "Methods for Solving Management Problems Involving Multiple Objectives" in G. Fandel and T. Gal (Eds.): "Multiple Criteria Decision Making. Theory and Application", Berlin, Springer-Verlag, 1980, pp. 540-558.